

Remarks/Arguments

Applicants respectfully request further examination and reconsideration in view of the above amendments and arguments set forth fully below. Claims 1, 8-27, 29-33, 35-127 were previously pending in the present application. Claims 9, 11, 15-18, 20-27, 33, 35-37, 39, 42, 43, 45-127 are withdrawn from consideration. By the above amendments, Claims 1 and 19 are amended. Accordingly, Claims 1, 8, 10, 12-14, 16, 17, 19, 29-32, 38, 40, 41 and 44 are currently pending in this application.

Within the Office Action, it is stated that the amendment filed on April 7, 2008 effectively canceling all claims drawn to the elected invention and presenting only claims drawn to a non-elected invention is non-responsive. Specifically, it is stated that the remaining claims are not readable on the elected invention because the elected species which applicant was required to fully illustrate, and did so in Figure 21, do not illustrate the now claimed "integrally disposed" heat source and "heat exchanging layer."

The Applicants inadvertently incorporated a feature from a non-elected species. The Applicants now present claims readable on the elected species that is fully illustrated in Figure 21. The following remarks/arguments are in response to the Office Action mailed on January 28, 2008.

Drawing Requirement

In the Applicants' response of November 9, 2007, the Applicants submitted a duplicate of Figure 21 because the Applicants indicated that the response of November 9, 2007 includes the response of July 27, 2007. The Applicants did not intend the duplicate of Figure 21 to be a the replacement sheet. It is stated within the Office Action that the Examiner is unsure which drawing is the replacement drawing and requests a properly labeled replacement sheet. Since the Applicants did not intend the duplicate of Figure 21 to be the replacement sheet, a properly labeled replacement sheet is not included in this response.

Rejections under 35 U.S.C. §112

Within the Office Action, Claims 1, 8, 10, 12-14, 16, 17, 19, 29-32, 38, 40, 41 and 44 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Specifically, the Examiner states that in Claim 1, it is unclear whether Applicant are claiming the combination of a heat exchanger and heat source or just the heat exchanger alone.

The Applicants have amended Claim 1 to recite “a body having a conducting portion configured to be in contact with a heat source.” It is clear from this amendment that Claim 1 claims the heat exchanger alone. Support for this limitation is found on page 13, lines 22-23. Claims 8, 10, 12-14, 16, 17, 19, 29-32, 38, 40, 41 and 44 are dependent on the independent Claim 1. For at least this reason, the Applicants respectfully request that the rejection of Claims 1, 8, 10, 12-14, 16, 17, 19, 29-32, 38, 40, 41 and 44 under 35 U.S.C. §112, second paragraph, be withdrawn.

Rejections under 35 U.S.C. §102 and §103

Within the Office Action, Claims 1, 10, 12-14, 17, 19, 32, 38 and 40 are rejected under 35 U.S.C. §102(b) as being anticipated by, or, in the alternative, under 35 U.S.C. §103(a) as obvious over U.S. Patent No. 5,761,037 to Anderson et al. (hereafter “Anderson”). The Applicants respectfully traverse this rejection for at least the following reasons.

Anderson teaches an evaporator for cooling components. [Anderson, Abstract] The evaporator includes a housing for containment of the working fluid. The housing has a surface 104 which is placed in thermal contact with the object body, chip or module to be cooled. The evaporator housing has a heated surface 104 and cap 105. A wicking layer 103 is immediately adjacent to the surface 104. [Anderson, column 3, lines 45-59] The evaporator includes wick member 102 and optional wicking spreader 101. [Anderson, column 3, line 65 through column 4, line 3] The cap 105 is provided with an inlet port 106 and an exhaust port 107 situated along the perimeter of the cap 105. [Anderson, column 4, lines 18-20] The surface 104 is in thermal contact with the chip 30, which is disposed on a printed circuit board 31. [Anderson, column 4, lines 48-52] However, Anderson does not teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*. Further, Anderson does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*.

In contrast to Anderson, the present invention is directed to a heat exchanger. The heat exchanger comprises an interface layer that performs thermal exchange with the heat source and is configured to pass fluid from a first side to a second side. [Present Specification, Abstract] The heat exchanger is coupled to a heat source. [Present Specification, page 13, lines 22-23] As illustrated in Figure 21, the manifold layer has a series of channels and ports formed therein.

Fingers branch out from the channels and extend completely through the body of the manifold layer in the X and Z-directions. For example, a finger can be parallel or perpendicular to other fingers. Fluid enters the inlet port and flows along the inlet channel to several fingers which branch out from the channel to apply fluid to selected regions in the interface layer. Also as illustrated in Figure 21, the bottom surface of the manifold layer abuts against the top surface of the intermediate layer. Fluid flows freely to and from the intermediate layer and the manifold layer. Specifically, the intermediate layer includes a plurality of conduits which extend therethrough. The inflow conduits direct fluid entering from the manifold layer to the designated interface hot spot regions in the interface layer. Figure 21 also illustrates a microporous structure disposed upon the interface layer. As described above, Anderson does not teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*. Further, Anderson does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*.

The independent Claim 1 teaches a heat exchanger. The heat exchanger of Claim 1 comprises a body having a conducting portion configured to be in contact with a heat source, wherein the conducting portion conducts heat from the heat source to a heat exchanging layer configured within the body, the body including at least one inlet port and at least one outlet port, wherein the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanging layer via an intermediate layer with a plurality of conduits which extend therethrough, the heat exchanging layer includes a porous microstructure disposed thereon and is configured to distribute the fluid and to pass the distributed fluid therethrough, further wherein the fluid is distributed such that at least one interface hot spot region in the heat source is selectively cooled. As described above, Anderson does not teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*. Also as described above, Anderson does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*. For at least these reasons, the independent Claim 1 is allowable over Anderson.

Claims 10, 12-14, 17, 19, 32, 38 and 40 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Anderson. Accordingly, Claims 10, 12-14, 17, 19, 32, 38 and 40 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 1, 10, 12-14, 17, 19, 32, 38 and 40 are rejected under 35 U.S.C. §103(a) as obvious over the combined teachings of Anderson and U.S. Patent No. 5,983,997 to Hou (hereafter “Hou”) or U.S. Patent No. 5,239,200 to Messina et al. (hereafter “Messina”). The Applicants respectfully traverse this rejection for at least the following reasons.

As described above, Anderson does not teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*. In addition, Anderson does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*.

Hou teaches a system for cooling electronic components including a cold plate. The cold plate has a channel through which a fluid coolant is transported, a plurality of bosses each receiving a heat generating component, and a plurality of fin structures. Each fin structure contacts a boss and has a fin inlet and a fin outlet in fluid communication with a section of the channel for supplying the area around the boss with coolant and cooling the component seated on the boss. Sections of the channel in the serpentine path further transport the coolant in opposite directions, thus enhancing heat transfer and temperature equilibration across the cold plate. [Hou, Abstract] Hou does not teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*. Instead, the heat generating component of Hou is secured to each boss by drilling and tapping the boss and providing a screw or other fastening member through the component. [Hou, col. 4, lines 21-24] Further, Hou does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*. Accordingly, neither Anderson, Hou, nor their combination teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*, or that *the heat exchanger layer includes a porous microstructure disposed thereon*.

Messina teaches an apparatus for cooling an array of integrated circuit chips mounted on a substrate. [Messina, Abstract] Disposed in a cooling relationship over the array of chips is a heat transfer module. A cold plate is disposed in a cooling relationship over heat transfer module. [Messina, column 3, lines 14-20] To provide a sealed enclosure for the coolant, an overhead cover member is disposed over cooling plate. [Messina, column 3, lines 42-45] An inlet and outlet are provided through cover surface on opposite ends of the cover to permit entry and exit of the coolant fluid. [Messina, column 4, lines 3-6] Messina does not teach that *the at least*

one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough. Instead, the baffles of the cover and the channels of the cooling plate to direct and permit coolant flow, as illustrated in Figure 1. The two piece construction of the present invention are bolted or otherwise fastened to each other through interior fastener openings in the cooling plate and cover. [Messina, col. 4, lines 14-18] Further, Messina does not teach that *the heat exchanger layer includes a porous microstructure disposed thereon*. Accordingly, neither Anderson, Messina, nor their combination teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*, or that *the heat exchanger layer includes a porous microstructure disposed thereon*.

As discussed above, neither Anderson, Hou, nor their combination teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*, or that *the heat exchanger layer includes a porous microstructure disposed thereon*. Also as discussed above, neither Anderson, Messina, nor their combination teach that *the at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanger layer via an intermediate layer with a plurality of conduits which extend therethrough*, or that *the heat exchanger layer includes a porous microstructure disposed thereon*. For at least these reasons, the independent Claim 1 is allowable over the teachings of Anderson, Hou, the combination of Anderson and Hou, Messina, and the combination of Anderson and Messina.

Claims 10, 12-14, 17, 19, 32, 38 and 40 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Anderson, Hou, the combination of Anderson and Hou, Messina, and the combination of Anderson and Messina. Accordingly, Claims 10, 12, 13, 14, 17, 19, 32, 38 and 40 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claim 8 is rejected under 35 U.S.C. §103(a) as unpatentable over Anderson alone or in view of Hou or Messina as applied to Claim 1, and further in view of U.S. Patent No. 3,993,123 to Chu (hereafter "Chu"). The Applicants respectfully traverse this rejection for at least the following reasons.

Claim 8 is dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Anderson, Hou, the combination of Anderson and Hou, Messina, and the combination of Anderson and Messina. Accordingly, Claim 8 is also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claim 16 is rejected under 35 U.S.C. §103(a) as unpatentable over Anderson alone or in view of Hou or Messina as applied to Claim 1, and further in view of U.S. Patent No. 4,758,926 to Herrell (hereafter “Herrell”). The Applicants respectfully traverse this rejection for at least the following reasons.

Claim 16 is dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Anderson, Hou, the combination of Anderson and Hou, Messina, and the combination of Anderson and Messina. Accordingly, Claim 16 is also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 29-32 is rejected under 35 U.S.C. §103(a) as unpatentable over Anderson alone or in view of Hou or Messina as applied to Claim 1, and further in view of U.S. Patent No. 6,680,044 to Tonkovich (hereafter “Tonkovich”). The Applicants respectfully traverse this rejection for at least the following reasons.

Claims 29-32 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Anderson, Hou, the combination of Anderson and Hou, Messina, and the combination of Anderson and Messina. Accordingly, Claims 29-32 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 1, 8, 10, 12-14, 16, 17, 19, 29-32, 38 and 40 are rejected under 35 U.S.C. §103(a) as obvious over the combined teachings of Herrell in view of the Jiang et al. article “Thermal-Hydraulic performance of small scale micro-channel and porous-media heat exchangers” (hereafter “Jiang”). The Applicants respectfully traverse this rejection for at least the following reasons.

Herrell teaches an integrated circuit chip having a conducting portion 40, an intermediate layer 44 and a silicon layer 46. [Herrell, Figure 2] The conducting portion 40 has a plurality of microchannels formed therein to receive a cooling fluid and located adjacent to the integrated circuits. [Herrell, col. 6, lines 9-13] The intermediate layer 44 and the silicon layer 46 have formed therein manifolds through which cooling fluid is conducted from the fluid inlet wherein upon the fluid enters the manifolds and passes into the microchannels. [Herrell, col. 6, lines 47-

51] As illustrated in Figures 5 and 6, not only are the microchannels parallel to each other, the manifolds are also parallel to each another. As such, Herrell does not teach *fingers that branch out in a plurality of directions from the at least one inlet port*. Further, Herrell does not teach *porous microstructures* as claimed by the Applicants; Jiang is apparently cited for this reason.

In Jiang, the flow and heat transfer performances of a micro-channel heat-exchanger and a micro-porous heat-exchanger are theoretically and experimentally investigated and evaluated. The experimental apparatus consisted of water tanks, pumps, a test section, regulator valves, accurate manometers, instrumentation to measure temperatures, an electric heater system and filters. The test section contained either a micro-channel heat-exchanger or a micro-porous heat-exchanger. [Jiang, page 1041] The heat-exchangers are fabricated from stacked cooper plates. To manufacture the micro-channel heat-exchanger, the stack is heated until soldering tin is melted. To manufacture the micro-porous heat-exchanger, the stack is sintered together with small copper particles. The heat-exchangers are packaged and sealed. [Jiang, page 1041-1042] No where in Jiang does Jiang teach *fingers that branch out in a plurality of directions from the at least one inlet port*.

Accordingly, neither Herrell, Jiang nor their combination teach *fingers that branch out in a plurality of directions from the at least one inlet port*. For at least this reason, the independent Claim 1 is allowable over Herrell, Jiang and their combination.

Claims 8, 10, 12-14, 16, 17, 19, 29-32, 38 and 40 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Herrell, Jiang and their combination. Accordingly, Claims 8, 10, 12-14, 16, 17, 19, 29-32, 38 and 40 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 1, 8, 10, 12-14, 16, 17, 19, 29, 30-32, 38 and 40 are rejected under 35 U.S.C. §103(a) as being unpatentable over Herrell in view of U.S. Patent No. 4,896,719 to O'Neill (hereafter "O'Neill") and Tonkovich. The Applicants respectfully traverse this rejection for at least the following reasons.

As described above, Herrell does not teach *fingers that branch out in a plurality of directions from the at least one inlet port*. Further, Herrell does not teach *porous microstructures*.

O'Neill teaches a plenum in combination with a heat exchange panel and a panel structure having a large number of closely spaced orifices of equal size. [O'Neill, Abstract] A conduit provides fluid to the panel structure. [O'Neill, column 2, lines 8-10] The fluid is forced into the heat exchanging panel through orifices and out of the heat exchanging panel through

orifices. [O'Neill, col. 3, lines 13-18] O'Neill does not teach that *at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanging layer via an intermediate layer with a plurality of conduits which extend therethrough*. Instead, O'Neill teaches that a heat exchange medium directed into the plenum through conduit 16 travels up through orifices 18 to panel 14, then returns from 14 to exhaust down through the plenum via tubes 23. [O'Neill, col. 2, lines 61-67] Further, O'Neill does not teach *porous microstructures*.

Tonkovich teaches chemical reactors and reaction chambers and methods for conducting chemical reactions having gas phase reactants. [Tonkovich, Abstract] Tonkovich does not disclose a heat exchanging system. As such, Tonkovich does not teach that *at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanging layer via an intermediate layer with a plurality of conduits which extend therethrough*. Further, Tonkovich does not teach *porous microstructures*.

Accordingly, neither Herrell, O'Neill, Tonkovich nor their combination teach *fingers that branch out in a plurality of directions from the at least one inlet port*, or *microporous structures*. For at least these reasons, the independent Claim 1 is allowable over the teachings of Herrell, O'Neill, Jiang and their combination.

Claims 8, 10, 12-14, 16, 17, 19, 29, 30-32, 38 and 40 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over Herrell, O'Neill, Jiang and their combination. Accordingly, Claims 8, 10, 12-14, 16, 17, 19, 29, 30-32, 38 and 40 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 1 and 32 are rejected under 35 U.S.C. §102(b) as being anticipated by, or, in the alternative, under 35 U.S.C. §103(a) as obvious over O'Neill. The Applicants respectfully traverse this rejection for at least the following reasons.

As described above, O'Neill does not teach that *at least one inlet port channels fluid to fingers which branch out in a plurality of directions from the at least one inlet port to the heat exchanging layer via an intermediate layer with a plurality of conduits which extend therethrough*, or *microporous structures*. For at least these reasons, the independent Claim 1 is allowable over O'Neill.

Claim 26 is dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over O'Neill. Accordingly, Claim 26 is also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 29-32 are rejected under 35 U.S.C. §103(a) as being unpatentable over O'Neill as applied to Claims 1 and 32, and further in view of Tonkovich. The Applicants respectfully traverse this rejection for at least the following reasons.

Claims 29-32 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable over O'Neill. Accordingly, Claims 29-32 are all also allowable as being dependent upon an allowable base claim.

Within the Office Action, Claims 41 and 44 are rejected under 35 U.S.C. §103(a) as being unpatentable over any of the prior art reference as applied to Claim 1, and further in view of US Patent No. 5,918,469 or International Publication WO 01/25711 A1 to Cardella (hereafter "Cardella"). The Applicants respectfully traverse this rejection for at least the following reasons.

Claims 44 and 41 are dependent on the independent Claim 1. As discussed above, the independent Claim 1 is allowable. Accordingly, Claims 41 and 44 are all also allowable as being dependent upon an allowable base claim.

The Applicants respectfully request examination and reconsideration in view of the amendments above and remarks above. Following the above amendments, Claims 1, 8, 10, 12-14, 16, 17, 19, 29-32, 38, 40, 41 and 44 are currently pending. Should the Examiner have any questions or comments, he or she is encouraged to call the undersigned at (408) 530-9700 to discuss the same so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
HAVERSTOCK & OWENS LLP

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